Prescribing Exercise

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"Topics in Primary Care Medicine" presents articles on common diagnostic or therapeutic problems encountered in primary care practice. Physicians interested in contributing to the series are encouraged to contact the series' editors.

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Regular physical exercise provides both physical and psychological benefits. Adaptations to training include increased oxygen use by the exercising muscles, decreased myocardial oxygen consumption for a given workload and thus improved work and exercise capabilities. Exercise also reduces cardiovascular risk factors (blood pressure and lipoproteins), aids in weight reduction, retards osteoporosis and is an important adjunct to physical rehabilitation. Psychological accompaniments of training result in reduced anxiety and depression and an enhanced sense of well-being.

As therapy, exercise has indications, contraindications and side effects. Following appropriate medical evaluation, an exercise prescription can be recommended that will give maximum benefit with minimal risk.

Preexercise Evaluation

Before exercise testing or conditioning, a careful history of the cardiovascular, pulmonary, metabolic and musculoskeletal systems is necessary. Information suggesting a history of a myocardial infarction, claudication or obstructive lung disease should be sought; any of these conditions can limit exercise performance and modify the exercise prescription. Musculoskeletal problems can prevent a patient from doing certain exercises, thus altering the type of activity prescribed. Assessing previous physical and occupational activities helps determine the present level of fitness and types of exercise enjoyed. Known cardiac risk factors such as hypertension, cigarette smoking, hyperlipidemia, diabetes and a family history of early coronary disease should be identified. Using oral contraceptive drugs adds additional cardiovascular risk to women who also smoke during their late childbearing years.

A medication history is essential for the interpretation of testing and monitoring an exercise program. For example, β-blockers reduce the resting heart rate and attenuate exercise limits. Substances with anticholinergic effects can alter temperature regulation and necessitate modification of training practices. Diabetic patients usually require a reduction of their insulin dosage to avoid exercise-induced hypoglycemia.

The pretraining physical examination should focus on the peripheral vascular and cardiopulmonary systems. Diminished arterial pulsations or the presence of a bruit often indicate peripheral vascular disease and alter training mode and capacity. Auscultatory findings of a third or fourth heart sound imply reduced ventricular compliance, whereas a systolic heart murmur can suggest either aortic stenosis or idiopathic hypertrophic cardiomyopathy (or subaortic stenosis [IHSS]). The latter entity is the most common cause of cardiovascular death in young adults during exercise. A prominent fourth heart sound is usually present in patients with IHSS. Simple clinical techniques that alter the ventricular volume assist in identifying this abnormality. They include an increased intensity of the murmur after Valsalva's maneuver or a reduction of its intensity when the lower extremities are raised. In addition, nearly all patients with hypertrophic cardiomyopathy have abnormalities on their resting electrocardiogram. If a clinician believes the murmur to be more than innocent, echocardiography is indicated to determine its cause.

Physical and laboratory variables should be assessed before exercise and followed throughout the course of

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ABBREVIATIONS USED IN TEXT

ECG = electrocardiogram
IHSS = idiopathic hypertrophic subaortic stenosis
V_{O_2} max = maximal oxygen consumption

training. Changes in these measures can be used to follow the effects of the exercise program. Although underwater weighing is more precise, measuring skinfold thickness at several sites via skinfold calipers is a convenient method to quantitate body fat. Evaluating the alignment, stability and range of motion of the major joints allows for appropriate modification of the type of activity involved in training. Body strength can be approximated by measuring the maximal isometric handgrip with a dynamometer.

Laboratory investigation provides information pertaining to exercise functional capacity and predictors of cardiovascular disease. A hematocrit is determined to assess the potential oxygen-carrying capacity of a patient's blood. Serum glucose and cholesterol determinations assist in identifying persons with coronary risk factors. High-density-lipoprotein cholesterol levels should be done only in those patients who have hypercholesterolemia or a family history of early atherosclerosis. Triglyceride levels need not be routinely evaluated, as their value as a risk marker for coronary heart disease is still unclear. The serum potassium level should be measured in all patients taking diuretics because hypokalemia can lead to serious cardiac arrhythmias during exercise and render patients more susceptible to rhabdomyolysis. Depending on a particular person's history or signs, an electrocardiogram, chest radiograph and other laboratory tests may be done.

Exercise Testing

Graded exercise testing is useful in identifying risks to physical exertion, measuring functional capacity and establishing guidelines for training. The American College of Sports Medicine recommends exercise testing for all sedentary patients older than 35 years before beginning a conditioning program. We recommend graded exercise testing for men who are older than 35 years and relatively inactive. Because coronary artery disease is less prevalent in younger women, the predictive value of stress electrocardiography is considerably less among this group. Therefore, for women patients up to 45 years without a history of heart disease or other contraindications, we allow progressive training without prior exercise testing.

Many maximal exercise electrocardiographic (ECG) protocols using either a treadmill or a bicycle ergometer have been developed. Exercise testing should always include continuous ECG monitoring, resting and exercise heart rates, blood pressure determinations at various workloads and the maximum heart rate attained. Although not always reliable, the predicted maximum heart rate may be estimated by subtracting a patient's age from 220. Thus, a normal 40-year-old patient's maximum attainable heart rate would be about 180 beats per minute. This estimation should be substituted by the maximal level attained during stress testing.

During exercise ECG testing, the development of arrhythmias, horizontal or downsloping ST-segment depression of 1 mm or more or upsloping of the ST segment equal to or more than 1 mm 80 ms from the J point are electrocardiographic criteria suggestive of ischemic heart disease. Other ECG predictors of coronary artery disease include ST-segment elevation, R-wave voltage increase, serious ventricular arrhythmias occurring at low heart rates (120 to 130 beats per minute) and a reduced heart rate response to increasing exercise workloads. Symptoms of anginal pain add significance to the presence of ischemic-appearing ST segments during exercise. Blood pressure responses during exercise testing are also important; a reduction in blood pressure early in the testing protocol is often a sign of reduced cardiac output and severe coronary disease. In addition, increases in diastolic blood pressure and an inability to do three minutes of exercise are indicators of coronary atherosclerosis.

Interpretation of a positive test depends on both clinical and electrocardiographic findings. Besides coronary artery disease, ischemic-appearing electrocardiographic responses during stress testing can be the result of aortic stenosis, hypertension, left ventricular hypertrophy, anemia, hyperventilation or merely a variant of normal. A nonfasting state, hypokalemia and certain medications, such as digitalis, can also result in false-positive values. The predictive accuracy of stress testing for the diagnosis of coronary artery disease depends on the clinical presentation, age and gender of a patient. For example, a 45-year-old man with typical anginal chest pain and 2 mm of ST depression during exercise testing has a 98% probability of significant coronary disease. A similarly aged asymptomatic woman with the same ST depression has only a 10% likelihood of having coronary atherosclerosis. In asymptomatic persons, the predictive value of the graded exercise test for coronary heart disease increases when ischemic responses are noted at lower levels of exertion (stages I through III of the Bruce protocol) and at lower heart rates (below 160). Stress scintigraphy for perfusion defects or coronary arteriography (or both) can be used to evaluate cases of highly suspicious test results. A more complete strategy for evaluating a case of an asymptomatic patient with a positive test has recently been reviewed by Goldschlager. Additionally, exercise-related arrhythmias can be discovered during bicycle or treadmill testing, findings that will affect the intensity and duration of the exercise prescribed.

Besides the development of myocardial ischemia, graded exercise testing may be terminated because of dyspnea, dizziness, claudication or fatigue. The maximum attainable heart rate, limited by one of these symptoms, provides a guide for the intensity of training. Each patient's recommended level of physical activity can be determined and expressed as a percentage of either their maximal attainable heart rate or of maximal oxygen consumption (Vo_2 max). Maximal oxygen uptake relates to one's maximal ability to transport oxygen to exercising muscles. This depends on the circulating erythrocyte mass, maximum cardiac output (maximum heart rate times maximum stroke volume) and maximum arteriovenous oxygen difference. Vo_2 max is affected by age (decreasing after age 18), habitual activity (regular exercise increases use) and gender (men's greater than women's after puberty). Direct measurement of Vo_2 max is not generally available, but relatively accurate estimations of maximal oxygen uptake in persons without heart disease are based on heart rate responses to imposed workloads. However, estimation of Vo_2 max by submaximal exercise testing in patients with cardiovascular disease can be unreliable.

Contraindications

Absolute and relative contraindications to exercise are listed in Table 1. Absolute contraindications include the presence of acute or unstable cardiovascular and infectious diseases.

Relative contraindications should be weighed against the diagnostic or therapeutic benefits of exercise testing and training. They include uncontrolled metabolic disease (hyperthyroidism, hypothyroidism or diabetes) and chronic illness (chronic renal, hepatic or musculoskeletal disease) that would inhibit the development of a training effect. Patients with frequent ventricular ectopic activity, supraventricular tachycardia, ventricular aneurysm, moderate hypertension or significant anemia have an increased risk of complications during physical exertion and should exercise only under medical supervision.

TABLE 1.—*Contraindications to Exercise*

Absolute
Acute myocardial infarction (early)
Unstable angina pectoris
Active myocarditis
Dissecting aneurysm
Uncompensated congestive heart failure
Ventricular tachycardia and dysrhythmias
Severe aortic stenosis (valvular, supravalvular)
Severe hypertrophic cardiomyopathy
Thrombophlebitis
Recent pulmonary embolism
Acute infectious diseases
Severe systemic hypertension
Relative
Frequent ventricular ectopic activity
Supraventricular tachycardia
Ventricular aneurysm
Mild to moderate aortic stenosis
Mild to moderate hypertrophic cardiomyopathy
Anemia
Uncontrolled metabolic diseases (diabetes, myxedema, thyrotoxicosis)
Hypokalemia
Musculoskeletal disorders
Pulmonary hypertension

Exercise Prescription

An exercise prescription should include both the type of activity and guidelines for its intensity, duration and frequency. Based on the initial assessment, patients can be placed in one of the four following groups: (1) healthy, relatively young (men younger than age 35, women younger than age 45) with low cardiac risk; (2) apparently healthy, older patients (men older than age 35, women older than age 45) with a low cardiovascular risk profile and no abnormalities on exercise testing; (3) high risk for cardiac disease or abnormalities noted on graded exercise testing, and (4) established cardiac disease. Patients in groups 1 and 2 need only receive initial instruction and proceed to unsupervised training. Group 3 patients require initial supervision and may progress to unsupervised exercise after a reevaluation if training responses occur without complication. For patient safety, we believe group 4 patients should do exercise training only with appropriate supervision. However, because of economic and logistic constraints, those without severely depressed ventricular function, exercise-induced hypotension or complex ventricular arrhythmias can subsequently graduate to an unsupervised setting after a period of education and close monitoring.

The type of exercise is determined by a patient's desires and needs. Aerobic fitness is primarily enhanced through continuous rhythmic endurance activities of large muscle groups, such as brisk walking, jogging, cycling and swimming. Swimming and cycling result in low levels of musculoskeletal stress and can be done by those who have particular orthopedic impairments. Persons who work with their arms will derive more benefit from upper extremity exercise because there is little carry-over in the training response to "untrained" muscle groups. Racquet sports and games usually have an inadequate duration of continuous activity to produce a cardiovascular effect.

The intensity of endurance exercise (energy cost per unit of time) is often based on the MET (metabolic equivalent unit) system in the cardiovascular laboratory, whereas the pulse rate provides a basis for clinical monitoring. A MET unit is the approximate amount of energy expended (oxygen consumption) at rest (3.5 ml of oxygen per kg per minute). An adequate training intensity for endurance conditioning usually requires a heart rate response of between 70% and 85% of the maximal rate. The maximal rate can be estimated from the formula (220 minus age) mentioned or, when available, directly obtained from the results of exercise testing. Thus, a 40-year-old person with a maximum heart rate of about 180 beats per minute would have a target training pulse rate between 136 and 153 beats per minute.

The training heart rate for patients with coronary heart disease and angina pectoris should be either 50% to 70% of Vo_2 max of their anginal threshold or 70% to 85% of the heart rate response that precipitates chest pain or ischemic ECG changes. Similarly, patients who did not achieve their predicted maximum heart rate due to the development of other symptoms should train at 70% to 85% of their maximal attained heart rate. If a patient cannot exercise at this level, a reduced intensity for a longer duration should be encouraged, as endurance conditioning can occur even with lower training levels. Patients should be instructed on self-monitoring of their pulse rate with exercise and, with practice, will develop a sense of their exercise intensity that can guide subsequent training.

Each exercise session should begin with a 3- to 15-minute warm-up phase, which includes stretching of the muscles and tendons to be used during the activity. It is followed by a training period of 15 minutes to an hour and a cool-down phase, which usually consists of continued exercise at a reduced intensity to prevent postexercise hypotension. Exercise should be avoided soon after consuming alcohol or a heavy meal and during hot, humid and very cold weather. Proper dress for environmental conditions is mandatory.

The frequency of exercise should be a minimum of three training sessions that are equally spaced throughout the week. Although greater improvement in endurance conditioning results by increasing the duration and frequency of the exercise sessions, the risk of physical injury increases as well.

The first several weeks of training should be at a lower level of exertion—that is, 50% to 60% of the maximum heart rate—to allow for the development of motor skills and musculoskeletal conditioning. Following this, the duration, frequency and intensity of exercise can be gradually increased at two-week intervals, remembering that cardiovascular conditioning occurs best at exercise intensities that achieve a level of 70% to 85% of the maximum heart rate response. The intensity of exertion during training should never be prescribed beyond the level at which a patient has been tested.

Occupational demands or physical rehabilitation often require a specific training regimen; resistance exercises such as weight training are an example. Weight training can be beneficial for persons whose job involves lifting or pulling or for persons requiring specific musculoskeletal therapy. This isometric (static) activity helps develop greater strength but usually results in little or no endurance conditioning. Although strict isometric exertion has been only cautiously prescribed for patients who have cardiovascular disease, there is little objective evidence that this form of exercise is more hazardous than endurance activities. Because exercise ECG testing is generally restricted to endurance activities, however, patients with abnormalities identified during standard testing should limit training to endurance exercise. If isometric exercise is to be used, static testing with blood pressure and ECG monitoring should be done. Initially, weight training intensity should result in low levels of muscular tension. Slow progression toward higher resistance levels can be encouraged as strength increases.

Patients considered at high risk for complications during physical training should be followed in medically supervised programs in which close instruction, identification of contraindications and immediate treatment are available. Although infrequent, cardiac complications during exercise do occur. These include cardiac arrest, myocardial infarction and arrhythmias. Noncardiac complications, which are the most common cause of dropout from exercise programs, usually involve musculoskeletal injury. The most common include tendinitis, fractures and soft tissue injury.

Monitoring Training

Many cardiovascular adaptations are evident during the initial six weeks of training. Indicators of a conditioning effect include a decrease in resting pulse, a reduction in perceived exertion at previous intensities of exercise and the ability to handle greater workloads at the target heart rate. Documenting reductions in body fat, resting blood pressure and lipoprotein levels can be used as encouragement to continue exercising.

The use of the target heart rate and level of perceived exertion as a guide to training has been discussed. A useful intensity index of aerobic training is the ability to carry on a conversation during exercise. Inability to do this often indicates that the patient is training too vigorously and is beyond his or her anaerobic threshold.

Signs of overexertion can be manifest immediately or appear at a later time. Those that indicate immediate overexertion include inappropriate postexertional tachycardia (beyond ten minutes), angina, claudication, light-headedness, confusion, nausea, vomiting or uncontrolled dyspnea. More subtle indicators of overexertion that are delayed in onset are symptoms of prolonged fatigue, insomnia, or extreme muscle soreness often caused by rhabdomyolysis.

To maintain the benefits of exercise, physical activity must be continued on a regular basis. Fitness levels decrease to pretraining levels after several weeks of inactivity. Several weeks of exercise are needed for a patient to become accustomed to and enjoy a training regimen. Physician encouragement and frequent reinforcement of the projected long-term benefits of exercise are necessary during acclimatization to the exercise program. Structuring an exercise program to each person's needs, along with education and continued support, are usually required for success. Group participation is often useful in gaining patient acceptance and adherence to an exercise prescription.

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